

position controlling means for controlling a position of said light for recording relative to said optical information recording medium following up a motion of said optical information recording medium so that a same location on said optical information recording medium is irradiated with said light for recording for a certain time. --

--62. The optical information recording apparatus according to claim 61, wherein said position controlling means reciprocates said position of light for recording between said positioning information region and said data region to perform positioning control of said light for recording.--

--63. The optical information recording apparatus according to claim 61, wherein said data is recorded on said optical information recording medium utilizing holography and wherein said light for recording includes information light and reference light for recording, for recording said data on said optical information recording medium utilizing holography.--

--64. The optical information recording apparatus according to claim 63, wherein said reference light for recording is generated by spatially modulating a phase of light.--

--65. An optical information reproducing apparatus for reproducing information from an optical information recording medium having a positioning information region including positioning information for positioning reference light for reproduction and a data region on which data is recorded, said apparatus comprising:

reproducing reference light generating means for generating reference light for reproduction; and

position controlling means for controlling a position of said light for reproduction relative to said optical information recording medium following up a motion of said optical information recording medium so that a same location on said optical information recording medium is irradiated with said light for reproduction for a certain time.--

--66. The optical information reproducing apparatus according to claim 65, wherein said position controlling means reciprocates said position of light for reproduction between said positioning information region and said data region to perform positioning control of said light for reproduction.--

--67. The optical information reproducing apparatus according to claim 65, wherein said data is recorded on said optical information recording medium utilizing holography and wherein said light for reproduction is generated by spatially modulating a phase of light.--

--68. An optical information recording apparatus for recording information in an optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

1) a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source for emitting beams of light;

information light generation means for spatially modulating the beams of light emitted by the light source to generate information light carrying information;

recording reference light generation means for generating reference light for recording using the beams of light emitted by the light source; and

a recording optical system for illuminating the information recording layer on the same side thereof with the information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means such that the information is recorded in the information recording layer in the form of an interference pattern as a result of interference between the information light and the reference light for recording;

wherein the optical information recording medium has:

a recording region where the information can be recorded in the form of an interference pattern; and positioning regions provided on both sides of the recording region for positioning the information light and the reference light for recording, the apparatus further comprising control means for reciprocating illuminating positions of the information light and the reference light for recording by way of the recording region and at least a part of the positioning regions on both sides thereof so as to position the information light and the reference light for recording relative to the recording region following up a motion of said optical information recording medium based on information obtained from the positioning regions.--

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--69. An optical information reproducing apparatus for reproducing information from an optical information recording medium having an information recording layer with information recorded therein utilizing holography, the apparatus comprising:

a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source for emitting beams of light;

reproduction reference light generation means for generating reference light for reproduction using the beams of light emitted by the light source;

a reproducing optical system for illuminating the information recording layer with the reference light for reproduction generated by the reproduction reference light generation means and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

detection means for detecting the reproduction light collected by the reproducing optical system;

wherein the optical information recording medium has:

a recording region where information is recorded in the form of an interference pattern; and positioning regions provided on both sides of the recording region for positioning the reference light for reproduction, the apparatus further comprising control means for reciprocating illuminating positions of the reference light for reproduction by way of the recording region and at least a part of the positioning regions on both sides thereof so as to position the reference light for reproduction relative to the recording region following up a motion of said optical information recording medium based on information obtained from the positioning regions.--

91 --70. An optical information recording apparatus for recording information on an optical information recording medium having an information recording layer in which information is recorded utilizing holography, said apparatus comprising:

light separation means for dividing light emitted by a light source into first and second rays of light so that said first and second rays of light progress on optical axes different from each other;

information light generating means for spatially modulating said first ray of light based on information to be recorded to generate information light;

recording reference light generating means for generating reference light for recording based on said second ray of light;

light composition means for composing said information light and said reference light to locate on the same line optical axes of said information light and said reference light;

optical rotation means for rotating by a predetermined angle polarization directions of said information light and said reference light, each which progresses on the same optical axis;

recording means for illuminating said information recording layer with said information light and said reference light for recording each having said polarization direction rotated by said optical rotation means so that said information is recorded in said information recording layer in the form of an interference pattern as a result of interference between said information light and said reference light for recording; and

light detecting means for detecting reproduction light corresponding to said interference pattern formed in said information recording layer; and

verification means for verifying said information recorded based on said detected reproduction light.--

C1 --71. The optical information recording apparatus according to claim 70, wherein said verification means verifies said information recorded substantially at the same time as a recording operation by said recording means.--

--72. The optical information recording apparatus according to claim 70, wherein said optical information recording medium has a test area for a verifying operation.--

--73. The optical information recording apparatus according to claim 70, wherein said recording reference light generating means includes a phase modulator for spatially modulating a phase of light.--

--74. The optical information recording apparatus according to claim 72, wherein said verification means determines output characteristics of said light detecting means in response to an output level of said reproduction light from a test data recorded on said test area, and wherein said recording means controls a recording operation based on said output characteristics.--

--75. An optical information recording apparatus for recording information in an optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source for emitting beams of light;

information light generation means for spatially modulating the beams of light emitted by the light source to generate information light carrying information;

recording reference light generation means for generating reference light for recording using the beams of light emitted by the light source; and

a recording optical system for illuminating the information recording layer on the same side thereof with the information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means such that the information is recorded in the information recording layer in the form of an interference pattern as a result of interference between the information light and the reference light for recording;

wherein the light source emits the beams of light in a plurality of wavelength bands.--

--76. The optical information recording apparatus according to claim 75, wherein said information recording layer has plural areas of which optical characteristics are changed by only light in each of said plurality of wavelength bands.--

--77. An optical information reproducing apparatus for reproducing information from an optical information recording medium having an information recording layer with information recorded therein utilizing holography, the apparatus comprising:

a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source for emitting beams of light;

reproduction reference light generation means for generating reference light for reproduction using the beams of light emitted by the light source;

a reproducing optical system for illuminating the information recording layer with the reference light for reproduction generated by the reproduction reference light generation means and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

detection means for detecting the reproduction light collected by the reproducing optical system;

wherein the light source emits the beams of light in a plurality of wavelength bands, and the detection means detects the reproduction light in the same plurality of wavelength bands as those of the beams of light emitted by the light source.--

--78. The optical information reproducing apparatus according to claim 77, wherein said information recording layer has plural areas of which optical characteristics are changed by only light in each of said plurality of wavelength bands.--

--79. An optical information recording apparatus for recording information on an optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

an information light generation unit configured to generate plural information lights each which carries corresponding two dimensional pattern information;

a recording reference light generation unit, including a phase modulator for spatially modulating a phase of light, configured to generate plural reference lights for recording each which is spatially modulated by said phase modulator in response to a unique phase modulation pattern for said each two dimensional pattern information;

an optical recording unit configured to illuminate said information layer with said plural information lights and said plural reference lights for recording so that an optical axis of each information light and an optical axis of the corresponding reference light for recording are located on the same line, to perform a multiplex recording to record on the same location of said optical information recording medium information in the form of plural interference patterns as a result of interferences between said plural information lights and said plural reference lights for recording.--

--80. The optical information recording apparatus according to claim 79, wherein said optical recording unit performs said multiplex recording so that recording locations adjoining each other are overlapped in part in a certain direction on said optical information recording medium.--

--81. The optical information recording apparatus according to claim 79, wherein said optical recording unit records a same interference pattern on plural locations of said optical information recording medium.--

--82. The optical information recording apparatus according to claim 79, further comprising:

a two dimensional pattern information generation unit configured to generate said two dimensional pattern information by dividing information to be recorded into plural pieces of data,

wherein said optical recording unit performs said multiplex recording of said plural interference patterns spreading over plural locations on said optical information recording medium in a predetermined order.--

--83. The optical information recording apparatus according to claim 82, further comprising:

a parity generation unit configured to generate parity data based on said two dimensional pattern information,

wherein said optical recording unit records on said optical information recording medium plural interference patterns corresponding to said parity data based on a predetermined rule.--

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--84. The optical information recording apparatus according to claim 83, wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of said two dimensional pattern information, and said optical recording unit records all interference patterns corresponding to said plural sets of parity data on one location on said optical information recording medium.--

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--85. The optical information recording apparatus according to claim 83, wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of said two dimensional pattern information, and said optical recording unit records plural interference patterns corresponding to said plural sets of parity data spreading over plural locations, on each which includes an interference pattern corresponding to at least one of said plural sets of parity data.--

--86. An optical information recording apparatus for recording information on an optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

a first optical element for dividing light emitted by a light source into first and second rays of light so that said first and second rays of light progress on optical axes different from each other;

a spatial modulator for spatially modulating said first ray of light based on information to be recorded to generate information light;

a unit for generating reference light for recording based on said second ray of light;

a second optical element for composing said information light and said reference light for recording to locate on the same line optical axes of said information light and said reference light;

an optical rotation element for rotating polarization directions of said information light and said reference light, each which progresses on the same optical axis; and

an objective lens for collecting said information light and said reference light each passing through said optical rotation element to irradiate said information recording layer on the same side thereof with said collected information and reference light,

wherein an interference pattern as a result of interference between said information light and said reference light for recording is recorded in said information recording layer.--

--87. The optical information recording apparatus according to claim 90, wherein said optical information recording medium has a positioning region of recording positioning information for positioning said information light and said reference light for recording, said apparatus further comprising a position controller configured to control irradiation positions of said information light and said reference light for recording relative to said optical information recording medium using said positioning information on said positioning region.--

--88. The optical information recording apparatus according to claim 90, further comprising:

a fixing light source for fixing said interference pattern in said information recording layer.--

--89. An optical information reproducing apparatus for reproducing information from an optical information recording medium having an information recording layer in which said information is recorded in the form of an interference pattern as a result of interference between information light carrying said information and reference light for recording utilizing holography, said apparatus comprising:

a first optical separation element for dividing light emitted by a light source into first and second rays of light so that said first and second rays of light progress on optical axes different from each other;

a unit for generating reference light for reproduction based on one of said first and second rays of light;

an optical rotation element for rotating a polarization direction of said reference light for reproduction;

an objective lens for collecting said reference light passing through said optical rotation element to irradiate said interference pattern with said collected reference light for reproduction, wherein reproduction light is generated by irradiating said interference pattern with said reference light for reproduction and wherein the optical axes of said reproduction light and said reference light for reproduction are located on the same line;

a second optical separation element for locating on different lines each other said axes of said reference light for reproduction and said reproduction light and,

a detector for detecting said reproduction light from the same side of said information recording layer as the side from which said reference light for reproduction is applied.--

--90. The optical information reproducing apparatus according to claim 93, wherein said optical information recording medium has a positioning region of recording positioning information for positioning said reference light for reproduction,

said apparatus further comprising a positioning controller a position controller configured to control irradiation positions of said reference light for reproduction relative to said optical information recording medium using said positioning information on said positioning region.--

--91. An optical information recording medium comprising:

a first information layer for recording information in the form of an interference pattern as a result of interference between information light and reference light for recording utilizing holography and for generating reproduction light associated with the recorded information when illuminated with reference light for reproduction; and

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a second information layer which is provided in a position different from the position of the first information layer in the direction of the thickness and in which information is recorded using means different from that for the recording of information in the first information layer.--

--92. An optical information recording medium according to claim 95, wherein information for positioning the information light, the reference light for recording and the reference light for reproduction is recorded in the second information layer.--

--93. An optical information recording medium according to claim 95, wherein a gap having a predetermined thickness is formed between the first and second information layers.--

--94. An optical information recording medium according to claim 95, further comprising a spacer for separating the first and second information layers with a predetermined interval between them to form the gap.--

--95. An optical information recording medium according to claim 95, further comprising a transparent substrate provided between the first and second information layers to form the gap.--